skeleton is highly developed, the vertebræ appear to have the double concave articulation common amongst fish and enaliosaurs.

The author, in conclusion, acknowledges his obligations to Sir Philip M. de Grey Egerton, M.P., Dr. Mantell, Mr. Binney, Mr. J. E. Gray and Mr. Searles Wood, for their valuable co-operation in supplying many important specimens for examination.

4. "On the Mechanical Equivalent of Heat." By J. P. Joule, Cor. Associate R. Acad. Sciences, Turin, &c. Communicated by M. Faraday, D.C.L., F.R.S., Foreign Memb. Acad. of Sciences, Paris, &c.

After passing in review the experimental researches of Rumford, Davy, Dulong, Faraday, and others who have successively discovered facts tending to prove that heat is not a substance, but a mode of force, the author mentions the papers he has already communicated to the Royal Society, and published in the Philosophical Magazine, in which he has endeavoured to show that in the production of *heat* by the expenditure of *force*, and *vice versâ*, in the production of *force* by the expenditure of *heat*, a constant relation always subsists between the two. This relation he denominates the "Mechanical Equivalent of Heat," and the object of the present paper is to advance fresh proofs of its existence, and to give to it the numerical accuracy requisite to fit it as a starting-point for further inquiries.

In carrying out the above design, the author has determined the relation of *work done* to *heat produced* in the cases of the friction,—1st, of water; 2nd, of mercury; and 3rd, of cast iron.

In the experiments on the friction of the fluids, the liquid was contained in a covered cylindrical vessel of copper or iron, and the agitation was effected by vanes of brass or iron, fixed to a vertical axis revolving in the centre of the vessel, whilst fixed vanes prevented the liquid being whirled in the direction of rotation. In the experiments on the friction of solids, a disc of cast iron was rotated against another disc of cast iron pressed against it; the whole being immersed in a cast-iron vessel filled with mercury.

The *force expended* was measured by the descent of the weights employed in rotating the apparatus; and great care was taken to correct it for the friction of the axes of the pullies employed, &c.

The *heat evolved* by the friction was measured by exact thermometers, and very laborious precautions were taken in order to eliminate the effects of radiation or conduction of heat to and from the surrounding atmosphere. The corrected thermometric effect was then reduced to a known capacity for heat, by means of extensive series of experiments made in order to ascertain the specific heat of the materials in which the thermometric effect was observed.

In this way the number of units of work, estimated in pounds one foot high, required to be done in order to develope one degree Fahr. in one pound of water taken at about 50°, was found to be as follows:—

772·692 from friction of water, a mean of 40 experiments.
774·083 from friction of mercury, a mean of 50 experiments.
774·987 from friction of cast iron, a mean of 20 experiments.